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ANALYSIS OF OFF-STREET PARKING CAPACITY AT CIREBON SUPER BLOCK, CIREBON CITY

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ABSTRACT
Rapid population growth and economic progress have increased the need for public facilities such as shopping malls, hospitals, and office buildings. Cirebon Super Block (CSB) is one of the shopping centers in Cirebon City that adopts the 4-in-1 concept. However, CSB faced problems in providing adequate parking facilities, causing vehicle congestion at the mall entrance and traffic jams. This study aims to identify existing parking conditions, analyze the need for parking spaces, and provide technical recommendations to increase the availability of parking spaces in CSB. This study uses quantitative methods with primary and secondary data collection. The results of the study show that CSB has an off-street parking capacity of 808 SRP (standard parking spaces) for cars and 1188 SRP for motorcycles. The analysis shows that the highest parking index for cars occurred on Saturday reaching 101%, with the highest accumulation of 750 vehicles, the volume of 1011 vehicles, and the average parking duration of 1.75 hours. The highest parking index for motorcycles also occurred on Saturday reaching 91.1%, with the highest accumulation of 1082 vehicles, the volume of 1855 vehicles, and the average parking duration of 2,088hours. The implication of this study is to plan the construction of a parking building on the west side using Civil 3D software and convert an area of 720m² from 26 SRP to 111 SRP. This recommendation is expected to increase the parking capacity from 818 SRP to 918 SRP, so that it can reduce congestion and improve the comfort of CSB visitors.

Keywords: Parking, Parking Reorganization, Off-Street Parking, Parking Capacity.

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INTRODUCTION

Rapid population growth and economic progress have increased the need for public facilities such as shopping centers, hospitals, and office buildings (Tanaya & Rudiarto, 2014). Parking facilities are one of the important elements in the urban transportation system (Ginting & Sejahtera, 2018). According to Law No. 22 of 2009 concerning Road Traffic and Transportation, parking is defined as a condition in which a vehicle stops or does not move temporarily and is left by the driver (Basri, 2017).

A shopping center is a building designed to provide a variety of shops, outlets, and services in one location (Fauzi & Herindiyati, 2022). This place usually consists of various shops selling various goods such as clothing, electronics, food, and other products (Berliana, 2024). It can be equipped with restaurants, cinemas, and other entertainment facilities. The purpose of the shopping center is to provide comfort and convenience for consumers to meet their various needs in one integrated place, one of which is in the city of Cirebon, precisely at Cirebon Super Block Mall (CSB). Cirebon City is a city that has been designated as one of the metropolitan areas determined as the National

Activity Center (PKN) in the development of metropolitan areas, especially in the superior area, namely Ciayumajakuning (Cirebon City, Cirebon Regency, Indramayu, Majalengka, and Kuningan). Cirebon City is the center of rapid economic growth in the Ciayumajakuning region. It is an area with a high population density (Novriani et al., 2023). One of the shopping centers in the city of Cirebon is CSB mall, precisely on Jalan Dr. Cipto Mangunkusumo, which is a crowded area visited because of its strategic location and applies the 4 1 concept, which consists of retail outlets, lodging, office space, and shop houses and also available off-street parking areas. Off-street parking is a vehicle parking facility outside the edge of a specially made public road or supporting activities in parking lots and buildings (Sumarno et al., 2022).

Therefore, this shopping center needs help in providing parking facilities. One of the difficulties is providing parking spaces proportional to the actual demand, along with the frequent buildup of vehicles at the Mall entrance crossing. This causes congestion on Dr. Cipto Mangunkusumo Road and limited entrance access at CSB. Congestion occurs when a high volume of vehicles disrupts the traffic flow on a road (Gohae, 2023). Some main causes of congestion are increased private vehicles, an imbalance between the number of vehicles and road capacity, inadequate public transportation, and traffic accidents. The problem of traffic congestion is serious because of its impact in the form of wasted fuel costs, additional travel time, air pollution, and disruption of people's mobility (Apriyono & Rumlus, 2021). Efficiency can be achieved if parking facilities are provided by existing demand in order to minimize the congestion that occurs (Lianzah, 2017). This study aims to identify the existing parking conditions at Cirebon Super Block (CSB) and analyze data and parking space requirements. In addition, this research also seeks to provide technical recommendations to contribute and a solution to the problem of the availability of parking spaces in CSB. Cirebon Super Block (CSB) as the center of shopping activities in the city of Cirebon, located in a strategic location on Jalan Dr. Cipto Mangunkusumo. Cirebon Super Block (CSB) offers various facilities, including malls, hotels, offices, and shop houses, with operating hours from 10 am to 10 pm since 2006. The more complete facilities at CSB attract many visitors, which impacts the performance of parking facilities.

CSB provides off-street parking facilities for cars and motorcycles. The car parking lot, located in the open yard and parking building, has a capacity of 808 SRP vehicles. In comparison, the motorcycle parking lot has a capacity of 1,188 SRP vehicles and similar facilities (Dinas Komunikasi Informatika dan Statistik Kota Cirebon, 2023). The high visitation to CSB is reflected in the daily parking volume in 2023, with 1,552 cars and 2,232 motorized vehicles (Statistics, 2023). The increase in parking volume yearly indicates the need for alternatives to improve parking characteristics.

Based on these data, this study aims to analyze the existing parking capacity at CSB, determine the need for parking spaces at Cirebon Super Block (CSB), and provide technical recommendations by building a new parking lot on the west side using Autocad Civil 3D software that can be applied to meet the needs of parking spaces at Cirebon Super Block (CSB).

METHOD

In this study, the method used is to use quantitative methods, including surveying incoming vehicles, surveying outgoing vehicles, and analyzing the existing conditions of the parking area and parking space requirements. The data sources used in this study are primary and secondary data; primary data includes vehicle accumulation, vehicle volume and conditions of the existing parking area, and the duration of the pair then. Secondary data includes the research location plan, parking

area, and existing parking condition data from 2023 to 2024. A research series was also formed to make it easier to understand the research flow. The research series is a flow of activities arranged to display a systematic research series and inform about the research process from the initial stage to provide technical recommendations. The research area we chose was in Cirebon Super Block, West Java, one of the densest shopping centers in Cirebon, Indonesia.

Figure 2. Location of Cirebon Super Block
Source Google Maps. (2024).

Figure 3. Research Location of Parking Area
Source Google Maps. (2024).

According to the Head of Transportation and Head of General Land Transportation (1996), a parking area is designated as a temporary stop area for vehicles to complete activities within a certain period. Parking areas can be divided into two types: on-street and off-street parking. (Januriad & Utami, 2023). In this case, research was conducted to analyze off-street parking.

Off-street parking is a stopping area located off the public right of way, specially created to assist activities such as parking garages and bus stop buildings (Andra, 2020). On-road stops are severely restricted in metropolitan areas, so off-road stops are expected to increase. This study aims to determine the quality of stops in the exploration area, especially Cirebon Super Block.

The quality of the stop includes the basic characteristics used to survey the stop service and the existing stop problems in the inspection area. The quality of the stop will determine the condition of the stoppage in the centered area. Some viewpoints about the quality of stoppage are collection stoppage, volume stoppage, recording stoppage, turnover stoppage, and period stoppage.

Parking Accumulation

According to Hobbs (1979), parking accumulation is the number of vehicles parked in an area at a given time.

Accumulation = Ei- Ex + X ..... (1)

with:

Ei = Total incoming vehicles
Ex = Total outgoing vehicles
X = Total vehicles parked before the study.

Parking Volume

Parking volume is the total number of vehicles entering the parking lot plus the number of vehicles already in the parking lot during a given period.

Parking Volume = Ei + X..... (2)

with:

Ei = Total incoming vehicles

X = Total existing vehicles prior to the study

Parking Index

A parking index is a parameter used to measure the density or intensity of parking utilization (Numberi et al., 2021). It is calculated by dividing the number of available parking spaces by the total area of available parking spaces. The higher the parking index value, the higher the intensity of parking utilization.

Parking index (IP) =(Parking Accumulation)/(Parking Available) x 100 ..... (3)

The parking index describes the parking facility's situation, whether at capacity or overloaded. The following is an explanation of the parking index results:

IP < 100% indicates that the parking facility is functioning well, as the parking demand is within the normal capacity limit.

IP = 100% indicates that parking demand and capacity are balanced perfectly.

IP > 100% indicates that the parking facility is overloaded, where the parking demand exceeds the normal capacity or available capacity.

Parking time duration

Parking time duration is when a vehicle is in a parking location within a certain time interval.

Duration = Ex time - En time .....(4)

with:

Ex time = time when the vehicle exits the parking lot

En time = time when the vehicle enters the parking lot

Parking Turnover

Parking turnover is a measure that indicates how often a parking space is used in a given period (Pamungkas et al., 2022). It is calculated by dividing the number of vehicles entering or exiting the parking area by the total parking area available.

Parking Turnover = (Parking Volume)/(Available Parking Spaces) ..... (5)

RESULTS AND DISCUSSION

To find specific parking data, it is necessary to observe the actual capacity, get the accumulation value using formula (1), and find the parking volume using formula (2). Then, proceed to calculate the parking index as a parameter used to measure the density or intensity of the parking lot using the formula (3). After that, you can calculate parking turnover and parking duration. Below is an example of calculating the parking data for vehicles with the highest value.

Parking Accumulation Calculation

Parking accumulation = Ei - Ex + X

with:

Ei = Total incoming vehicles,

Ex = Total outgoing vehicles

X = Total vehicles parked before the study.

Parking accumulation at 17.00 - 18.00 hours

Unknown:

incoming vehicles (Ei) = 261 vehicles

exiting vehicles (Ex) = 210 vehicles

pre-parked vehicles (X) = 765 vehicles

parking accumulation value = (Ei - Ex) = (261 - 210) + 765 = 816

In order to make it easier to monitor the accumulated parking figures for cars and motorcycles during the three-day recording process, we have compiled a recapitulation in the form of the following table and graph.

Table 1. Recap of Car and Motorcycle Parking Accumulation Rates

Time	Accumulation (Car)			Accumulation (Motorcycle)		
	Saturday	Sunday	Monday	Saturday	Sunday	Monday
10:00:00 - 11:00:00	195	250	160	156	115	92
11:00:00 - 12:00:00	335	368	142	224	211	133
12:00:00 - 13:00:00	375	338	163	288	489	163
13:00:00 - 14:00:00	483	419	176	419	716	182
14:00:00 - 15:00:00	537	442	191	456	1000	259
15:00:00 - 16:00:00	638	556	245	464	1057	346
16:00:00 - 17:00:00	699	620	423	540	1073	483
17:00:00 - 18:00:00	816	694	522	829	840	724
18:00:00 - 19:00:00	657	686	466	1082	781	815
19:00:00 - 20:00:00	379	433	430	780	645	676
20:00:00 - 21:00:00	82	91	211	80	96	99

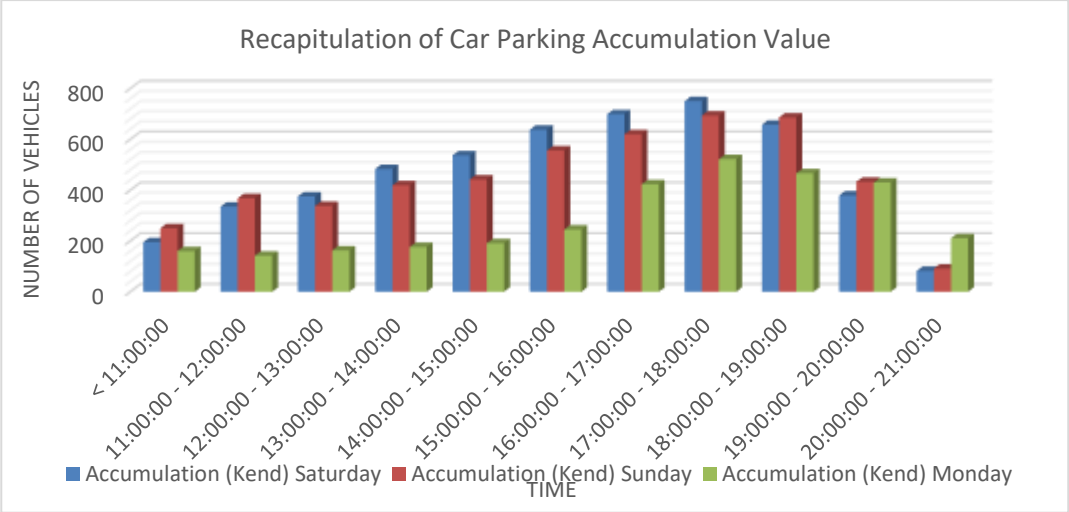

Figure 4. Car Parking Accumulation Chart

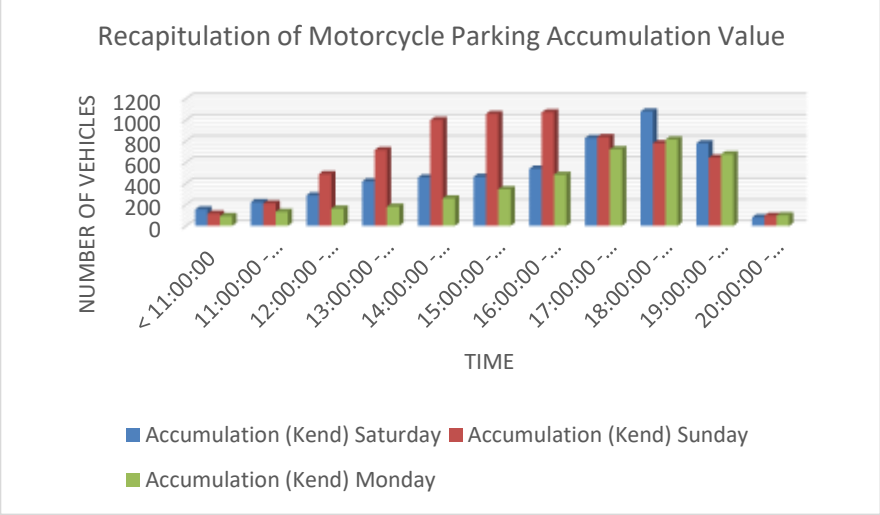

Figure 5. Motorcycle Parking Accumulation Chart

Parking Volume Calculation

Parking volume : Ei + X

with:

Ei = total incoming vehicles

X = total parked vehicles before observation

Parking volume during 17.00 - 18.00 hours

Unknown:

incoming vehicles (Ei) = 261 vehicles

previously parked vehicles (X) = 765 vehicles

parking volume = Ei - X = 261 + 765= 1026

To make it easier to monitor the parking volume figures for cars and motorcycles during the three-day recording process, we compiled a recapitulation in the form of the following table and graph.

Table 2. Recapitulation of Car and Motorcycle Parking Volume

Time	Volume (Car)			Volume (Motorcycle)		
	Saturday	Sunday	Monday	Saturday	Sunday	Monday
10:00:00 - 11:00:00	195	250	160	156	115	92
11:00:00 - 12:00:00	525	566	233	306	342	174
12:00:00 - 13:00:00	545	518	304	418	899	270
13:00:00 - 14:00:00	714	640	365	612	1083	413
14:00:00 - 15:00:00	722	617	287	686	1413	635
15:00:00 - 16:00:00	919	837	386	767	1324	900
16:00:00 - 17:00:00	959	871	709	737	1324	1203
17:00:00 - 18:00:00	1011	984	878	1328	1038	1584
18:00:00 - 19:00:00	904	933	677	1613	956	1855
19:00:00 - 20:00:00	499	561	615	999	790	983
20:00:00 - 21:00:00	196	191	381	269	218	209

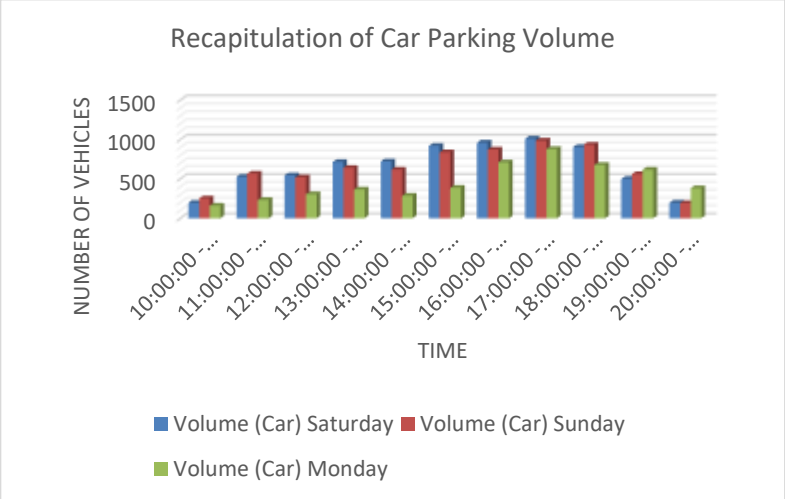

Figure 6. Car Parking Volume Chart

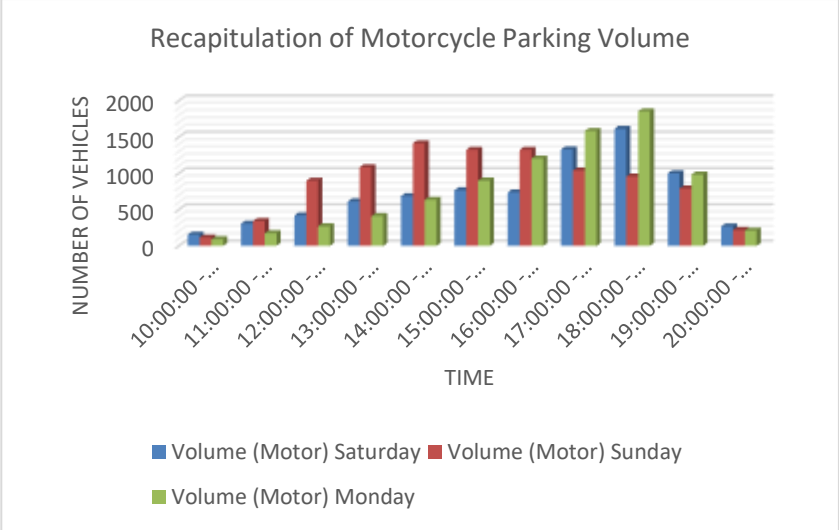

Figure 7. Motorcycle Parking Volume Chart

Parking Index Calculation

Parking Index = (Accumulated parking)/(available parking spaces) x 100%
= 816/808 x 100%
= 101%

To make monitoring the parking index figures for cars and motorcycles easier during the three-day recording process, we have compiled a recapitulation in the following table and graph.

Table 3. Recapitulation of Car and Motorcycle Parking Index Values

Time	Parking Index (Car)			Parking Index (Motorcycle)		
	Saturday	Sunday	Monday	Saturday	Sunday	Monday
10:00:00 - 11:00:00	11.40%	31.00%	19.80%	13.10%	9.70%	7.70%
11:00:00 - 12:00:00	16.50%	45.60%	17.60%	18.90%	17.80%	11.20%
12:00:00 - 13:00:00	20.20%	41.90%	20.20%	24.20%	41.20%	13.70%
13:00:00 - 14:00:00	22.60%	51.90%	21.80%	35.30%	60.30%	15.30%
14:00:00 - 15:00:00	32.10%	54.80%	23.70%	38.40%	84.20%	21.80%
15:00:00 - 16:00:00	42.90%	68.90%	30.40%	39.10%	89.00%	29.10%
16:00:00 - 17:00:00	59.90%	76.80%	52.40%	45.50%	90.30%	40.70%
17:00:00 - 18:00:00	89.70%	86.00%	64.70%	69.80%	70.70%	60.90%
18:00:00 - 19:00:00	101.00%	85.00%	57.70%	91.10%	65.70%	68.60%
19:00:00 - 20:00:00	83.80%	53.70%	53.30%	65.70%	54.30%	56.90%
20:00:00 - 21:00:00	12.30%	11.30%	26.10%	6.70%	8.10%	8.30%

Parking Duration Calculation

Duration = Ex time - En time

with:

Ex time = the time when the vehicle exits the parking area

En time = the time when the vehicle enters the parking lot

Example duration 1: Same-day parking

Entry time = 10:05

Exit time = 11:50

Calculation:

Hours: 11 – 10 = 1 hour

Minutes: 50 – 5 = 45 minutes
= 1 hour 45 minutes

Parking Turnover Calculation

Parking turnover = (Parking Volume)/(Available Parking Spaces)
= 1026/808
= 1.27 Vehicles/SRP

Interpretation: Each parking space/SRP is used, on average, by 1 - 2 vehicles in a 1-hour interval.

By recording for three consecutive days, namely Saturday, Sunday, and Monday, recording from 10:00 to 21:00 with a recording interval of 1 hour, we compiled a recapitulation of the results of the parking characteristics analysis in the following table.

Table 4. Recap of Research Results on Existing Car Parking Characteristics

Parameters	Saturday	Sunday	Monday
Highest Parking Accumulation	816	694	522
Highest Parking Volume	1026	984	878
Static Parking Capacity	808	808	808
Maximum turnover	1,27	1,21	1.088
Highest Parking Index (%)	101%	86.0%	64.7%
Average Duration of Parking (minutes)	105,26	100,28	86,28

Table 5. Recap of Research Results on Existing Parking Characteristics Motorcycle

Parameters	Saturday	Sunday	Monday
Highest Parking Accumulation	1082	1073	815
Highest Parking Volume	1613	1413	1855
Static Parking Capacity	1188	1188	1188
Maximum turnover	1,35	1,18	1.765
Highest Parking Index (%)	91.1%	90.3%	60.9%
Average Duration of Parking (minutes)	120,12	125,28	95,15

Next are the results recorded over three days on Saturday, Sunday, and Monday. The value of the parking index file on Saturday reached 100 percent, indicating that the current parking lot is inadequate to accommodate vehicles. However, the condition of motorcycle stops at Cirebon Super Block is still normal or ready to meet the needs of stopping. The parking index represents the total number of vehicles using an accessible parking space. The parking index calculation is completed by comparing the number of stops collected and the number of accessible parking spaces. Thus, the parking index figure becomes a reference to assess whether the parking lot's condition is still adequate to accommodate vehicles.

From the handling and inspection information, it was found that the record value of the car parking index was 101%. In comparison, the record value of the motorcycle parking index was only 91%. The option was to migrate the area used for the event to another area, which would then be designated as an additional vehicle parking lot. The elective arrangement can be seen in the attached figure.

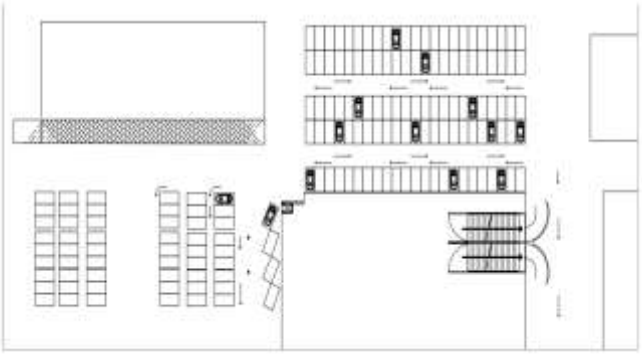

Figure 8. Alternative Plan for Parking Area

Unknown:

Accumulated car parking	= 750
number of car parking spaces	= 2
Plot size of recommendation area	= 60 x 12 m
	= 720 m2
Total recommendation area	= 2 x 720 m2
	= 1.440 m2
Car SRP dimension	= 2.4 x 5.4 = 12.96 m2

Then:

Additional car SRP	= 1.440 m2 : 12.96 m2
	= 111 SRP
Motorcycle parking space Alt 1	= 807 + 111
	= 918 SRP

Based on the additional parking space data obtained, the IP value of alternative 1 car (MC) is recalculated as follows:

IP ALT 1 (LV) = (accumulated parking)/(available parking spaces) x 100%

IP ALT 1 (LV) = 816/918 x 100%

IP ALT 1 (LV) = 89%

A summary of the parking index values of alternative 1 can be seen in the following table:

Table 6. Car and Motorcycle Alternative Parking Index Values

No.	Vehicle	Parking Accumulation	ALT 1 Parking Capacity (SRP)	ALT Parking Index 1 (%)
1	Car	816	918	89%
2	Motor	1082	1188	91%

Based on Table 6 above, it is known that the car parking index value based on the calculation of alternative recommendation 1 is 89%. Thus, the value of IP (LV) < 100% means problem-free parking where parking demand does not exceed normal capacity. While the motorcycle parking index value is 91%. Thus, the IP (MC) value < 100% means problem-free parking where parking demand does not exceed normal capacity.

Figure 9. Existing Parking Research Area

Figure 10. Recommended Parking Area Model

CONCLUSION

The results of a three-day study at Cirebon Super Block Mall revealed that motorcycle parking characteristics showed unsatisfactory conditions on Saturday. That day, the parking index reached its highest peak, 91.1%. The peak parking accumulation reached 1082 vehicles per hour, with a total parking volume of 1,855. The maximum turnover reached 1,765 vehicles per parking slot, and the average parking duration was 125.28 minutes.

The characteristics of car parking obtaining high index values also occurred on Saturday, with the highest parking index number reaching 101.0%. The peak parking accumulation was 750 vehicles/hour, the parking volume was 1,011 vehicles, the maximum turnover was 1.253 vehicles/SRP, and the average parking duration was 105.26 minutes.

Alternatively, when the current car park is overcapacity, parking realignment will be carried out in the Western car park space of CSB. This realignment will change the vacant land used for events, covering an area of 720 m², from 26 car SRPs to 111 car SRPs. Thus, the parking capacity will increase to 918 SRP in the West section of the Cirebon Super Block car park.

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